Readme File for the data presented in:

Enslin, C.L., Godsey, S.E., Marks, D., Kormos, P.R., Seyfried, M.S., McNamara, J.P., Link, T.E. (2016). A hydrological modeling dataset for the Johnston Draw catchment, Reynolds Creek Experimental Watershed, Idaho, USA, submitted to *Water Resources Research*, December, 2015.

For additional information on the dataset contact:
Dr. Daniel G Marks (Danny)
Research Hydrologist
Pacific West Area
USDA, Agricultural Research Service
800 PARK BLVD., STE 105
BOISE, ID, 83712
ars.danny@gmail.com
Phone: (208) 422-0721
Fax: (208) 334-1502

Data presented in the paper are all stored as ASCII text files, and include:

Meteorological_Data Directory:

Precipitation Sub-directory:

3 time-series precipitation files, ascii comma-separated (txt) with 1 header row – rc.tg.dc.jd-125_ppt.txt, rc.tg.dc.jd-124_ppt.txt, rc.tg.dc.jd-124b_ppt.txt

Data from all precipitation gauges in the JD watershed.
Precipitation for 125 and 124 were wind-corrected using the dual-gauge method described by *Hanson et al.* (2004). Precipitation for 124b was wind-corrected using wind data and the standard WMO method as applied by *Yang et al.* (1999). The percent snow was calculated using the methods developed by *Marks et al.* (2013), using the during-storm dew point temperature (T_d) where:

$T_d < -0.5\ ^oC$	100 % Snow
$-0.5\ ^oC >= T_d < 0\ ^oC$	75 % Snow
$0^oC <= T_d < +0.5\ ^oC$	25 % Snow
$0.5\ ^oC <= T_d$	0 % Snow

- 125 and 124b are a dual gauge precipitation stations (Pair of modified Belfort Universal gages, one shielded, one unshielded).

- 124b is a shielded gauge precipitation station (modified Belfort Universal Gage, with a wind sheild).

Each record in precipitation files contain Date_time, WY, Year, Month, Day, Hour, Minute, ppt_s, ppt_u, ppt_a, and pct_snow separated by comma.

Weather Sub-directory:

11 time-series weather station data files, ascii comma-separated (txt) with 1 header row - rc.tg.dc.jd-125_met.txt, rc.tg.dc.jd-124_met.txt, rc.tg.dc.jd-124b_met.txt, rc.tg.dc.jd-jdt1_met.txt, rc.tg.dc.jd-jdt2_met.txt, rc.tg.dc.jd-jdt2b_met.txt, rc.tg.dc.jd-jdt3_met.txt, rc.tg.dc.jd-jdt3b_met.txt, rc.tg.dc.jd-jdt4_met.txt, rc.tg.dc.jd-jdt4b_met.txt, rc.tg.dc.jd-jdt5_met.txt

Meteorological forcing data from all stations in the JD watershed.
Water vapor pressure (e_a) was calculated using air temperature (T_a), relative humidity (RH) and software tools (Image Processing Workbench, version 2.0) developed by *Marks et al.* (1999). T_d was

calculated using the calculated e_a. These IPW tools allow for optimized accuracy of e_a and T_d when temperatures approach 0°C. All parameters (T_a, RH, e_a, T_d, S_i, w_s, and w_d) were processed according to the WMO standards as summarized by *Zahumensk* (2004). All data were gap-filled using surrounding sites and multiple linear regression. Snow depth was processed using a snow filter tool created by Dr. Patrick Kormos. This tool requires a start and end of the snow season and maximum snow depth. From these, the filter tool creates a line of best fit using a custom user defined smoothing window. For more information on this tool, contact Dr. Patrick Kormos at Patrick.Kormos@ars.usda.gov.

– rc.tg.dc.jd-jdt1_met.txt, rc.tg.dc.jd-jdt2_met.txt, rc.tg.dc.jd-jdt4_met.txt, and rc.tg.dc.jd-jdt5_met.txt:
Each record contains Date_time, WY, Year, Month, Day, Hour, Minute, T_a, RH, e_a, and T_d separated by comma.

– rc.tg.dc.jd-jdt2b_met.txt, rc.tg.dc.jd-jdt3_met.txt, rc.tg.dc.jd-jdt3b_met.txt, and rc.tg.dc.jd-jdt4b_met.txt:
Each record contains date_time, WY, Year, Month, Day, Hour, Minute, T_a, RH, e_a, and T_d, w_s, and w_d separated by comma.

– rc.tg.dc.jd-125_met.txt, rc.tg.dc.jd-124_met.txt, rc.tg.dc.jd-124b_met.txt:
Each record contains Date_time, WY, Year, Month, Day, Hour, Minute, T_a, RH, e_a, and T_d S_i, w_s, and w_d separated by comma.

The instrumentation installed at each station in the JD watershed are as follows:

Vaisala HMP45C	- air temperature and humidity
Met One WS 034B	- wind speed
Met One WD 034B	- wind direction
Eppley PSP	- incoming solar radiation

Stream_Snow_Soils_Data Directory:

Soils Sub-directory:

9 time-series soil moisture and temperature files, ascii comma-separated (txt) with 1 header row - rc.tg.dc.jd-124ba_stm.txt, rc.tg.dc.jd-124bs_stm.txt, rc.tg.dc.jd-jdt1_stm.txt, rc.tg.dc.jd-jdt2_stm.txt, rc.tg.dc.jd-jdt2b_stm.txt, rc.tg.dc.jd-jdt3_stm.txt, rc.tg.dc.jd-jdt3b_stm.txt, rc.tg.dc.jd.jdt4_stm.txt, rc.tg.dc.jd-jdt4b_stm.txt

Soil temperature and moisture data from all JD sites. Soil temperature is serially complete and gap-filled whereas soil moisture has not been gap-filled. All soils files contain Date_time, WY, Year, Month, Day, Hour, Minute, Tg_*, sm_* separated by comma; - the suffix to Tg and sm indicate the depth in cm at which the sensors were installed.

Instrumentation = Stevens Hydra Probe SDI-12

Stream_Discharge Sub-directory:

1 time-series stream discharge file, ascii comma-separated (txt) with 1 header row – rc.tg.dc.jd-125b_sf.txt

Stream discharge measured at the outlet of the JD watershed. Stream discharge was processed using methods developed by *Pierson et al.* (2002).
The *rc.tg.dc.jd-125b_sf.txt* data file contains WY, Year, Month, Day, Hour, Minute, SD separated by comma.

Instrumentation = stage recorder, pressure transducer and drop box weir.

Snow_Depth Sub-directory:

11 time-series snow depth file, ascii comma-separated (txt) with 1 header row - rc.tg.dc.jd-125_zs.txt, rc.tg.dc.jd-124_zs.txt, rc.tg.dc.jd-124b_zs.txt, rc.tg.dc.jd-jdt1_zs.txt, rc.tg.dc.jd-jdt2_zs.txt, rc.tg.dc.jd-jdt2b_zs.txt, rc.tg.dc.jd-jdt3_zs.txt, rc.tg.dc.jd-jdt3b_zs.txt, rc.tg.dc.jd-jdt4_zs.txt, rc.tg.dc.jd-jdt4b_zs.txt, rc.tg.dc.jd-jdt5_zs.txt

Snow depth data from all JD sites. All snow depth files contain Date_time, WY, Year, Month, Day, Hour, Minute, z_s separated by comma. For more information on dates that were not gap-filled, refer to the supplemental information.

Instrumentation = Judd depth sensor

DEM sub-directory:
- This directory contains a Geotiff of the Johnston Draw watershed

Other information:
Information regarding the naming convention for stations can be found in the text filed called *Naming_Convention.pdf*. Information regarding the instrumentation installed at each station can be found in the text file called *Instrumentation_Information.pdf*.

Data time periods:
All data were collected at the Johnston Draw (JD) watershed, a sub-watershed of the Reynolds Creek Critical Zone Observatory, Idaho. The JD watershed was established by the Agricultural Research Services (ARS) in 2002 to study the rain-snow transition zone. The ARS installed 2 precipitation and meteorological stations (124, 125) in 2002, an additional 5 tripod stations measuring air temperature, humidity snow depth and wind to form an orographic transect across the rain-snow transition (jdt1, jdt2, jdt3, jdt4, and jdt5) in 2005, and 1 additional wind sheltered precipitation station (124b) in 2006. As all five orographic transect stations were on the north-facing slope, an additional 3 tripod stations (jdt2b, jdt3b, and jdt4b) were installed in 2010. At that time soil temperature and moisture profile systems were attached to all 8 tripod stations, and two profiles were connected to the met & ppt station at site 124b – one below the Aspen, and one in the open.

Data for each station for this dataset is available as following:

125b - 1 October 2003 through 30 September 2014 (11 WY)
Location (43.120808 °N, -116.7752263 °W WGS84 / 518285 Easting, 4774255 Northing, UTM, Zone 11)
Elevation: 1496 m MSL
96432 serially complete gap-filled records

125 - 1 October 2003 through 30 September 2014 (11 WY)
Location (43.123278 °N, -116.77641 °W WGS84 / 518188 Easting, 4774529 Northing, UTM, Zone 11)
Elevation: 1508 m MSL
96432 serially complete gap-filled records

124 - 1 October 2003 through 30 September 2014 (11 WY)
Location (43.129186 °N, -116.799392°W WGS84 /516316.9 Easting, 4775180.4 Northing, UTM, Zone 11)
Elevation: 1804 m MSL
96432 serially complete gap-filled records

124b - 11 November 2006 through 30 September 2014 (8 WY)
Location (43.128604°N, -116.79661°W WGS84 / 516543.4 Easting, 4775116.3 Northing, UTM, Zone 11)
Elevation: 1778 m MSL

69384 serially complete gap-filled records

jdt1 - 5 November 2005 through 30 September 2014 (9 WY)
Location (43.122318°N, -116.779436°W WGS84 / 517942.1 Easting, 4774421.8 Nothing, UTM, Zone 11)
Elevation: 1552 m MSL
78048 serially complete gap-filled records

jdt2 - 5 November 2005 through 30 September 2014 (9 WY)
Location (43.122927°N, -116.782798°W WGS84 / 517668.4 Easting, 4774488.7 Northing, UTM, Zone 11)
Elevation: 1613 m MSL
78048 serially complete gap-filled records

jdt2b - 4 March 2011 through 30 September 2014 (4 WY)
Location (43.125801°N, -116.782742°W WGS84 / 517672.2 Easting, 4774807.8 Northing, UTM, Zone 11)
Elevation: 1615 m MSL
31357 serially complete gap-filled records

jdt3 - 21 September 2005 through 30 September 2014 (9 WY)
Location (43.12188°N, -116.785609°W WGS84 / 517440.1 Easting, 4774371.8 Northing, UTM, Zone 11)
Elevation: 1658 m MSL
79128 serially complete gap-filled records

jdt3b - 13 December 2010 through 30 September 2014 (4 WY)
Location (43.125683°N, -116.78562°W WGS84 / 517438.1 Easting, 4774794.1 Northing, UTM, Zone 11)
Elevation: 1661 m MSL
33299 serially complete gap-filled records

jdt4 - 2 November 2005 through 30 September 2014 (9 WY)
Location (43.121593°N, -116.787987°W WGS84 / 517246.7 Easting, 4774339.4 Northing, UTM, Zone 11)
Elevation: 1707 m MSL
78120 serially complete gap-filled records

jdt4b - 4 March 2011 through 30 September 2014 (4 WY)
Location (43.126337°N , -116.788065°W WGS84 / 517239 Easting, 4774866.3 Northing, UTM, Zone 11)
Elevation: 1707 m MSL
31356 serially complete gap-filled records

jdt5 - 2 November 2005 through 30 September 2014 (9 WY)
Location (43.125644 °N , -116.794728 °W WGS84 / 516697.3 Easting, 4774787.9 Northing, UTM, Zone 11)
Elevation: 1748 m MSL
78120 serially complete gap-filled records

Missing data in each file are represented by *-9999*. Further descriptions of each file can be found below.

Header information includes:

Date_time	Date followed by time, separated by space (example: 10/01/03 12:00)
WY	Water Year
Year	Calendar Year
Month	Month of Year
Day	Day of Month

Hour	Hour of Day
Minute	Minute of Hour
T_a	Air Temperature ~3 m above ground surface (^{o}C)
RH	Relative Humidity ~3 m above ground surface (0 - 1)
e_a	Water Vapor Pressure ~3 m above ground surface (Pa)
T_d	Dew Point Temperature ~3 m above ground surface (^{o}C)
w_s	Wind Speed ~3 m above ground surface (ms^{-1})
w_d	Wind Direction ~3 m above ground surface (^{o} from N)
S_i	Incoming Solar Radiation (W m^{-2})
z_s	Snow Depth (cm)
ppt_s	Shielded Precipitation (mm)
ppt_u	Unshielded Precipitation (mm)
ppt_a	Wind Corrected Precipitation (mm)
pct_snow	Percent of precipitation that is snow (%)
sm_5	Soil Moisture a 5cm depth (m^{3} m^{-3} - dimensionless)
sm_20	Soil Moisture a 20cm depth (m^{3} m^{-3} - dimensionless)
sm_35	Soil Moisture a 35cm depth (m^{3} m^{-3} - dimensionless)
sm_50	Soil Moisture a 50cm depth (m^{3} m^{-3} - dimensionless)
sm_75	Soil Moisture a 75cm depth (m^{3} m^{-3} - dimensionless)
sm_90	Soil Moisture a 90cm depth (m^{3} m^{-3} - dimensionless)
sm_100	Soil Moisture a 100cm depth (m^{3} m^{-3} - dimensionless)
Tg_5	Soil Temperature a 5cm depth (^{o}C)
Tg_20	Soil Temperature a 20cm depth (^{o}C)
Tg_35	Soil Temperature a 35cm depth (^{o}C)
Tg_50	Soil Temperature a 50cm depth (^{o}C)
Tg_75	Soil Temperature a 75cm depth (^{o}C)
Tg_90	Soil Temperature a 90cm depth (^{o}C)
Tg_100	Soil Temperature a 100cm depth (^{o}C)
Q	Stream Discharge (m^{3} s^{-1})

References:

Hanson, C., F. Pierson, and G. Johnson, 2004, Dual-gauge system for measuring precipitation: historical development and use, *Journal of Hydrologic Engineering*, **9**(5), 350 – 358.

Marks, D., J. Domingo and J. Frew, 1999, *Software tools for hydro-climatic modeling and analysis: Image Processing Workbench, ARS - USGS Version 2*. ARS Technical Bulletin **NWRC-99-1**, Northwest Watershed Research Center, USDA Agricultural Research Service, Boise, ID, Electronic Document: http://cirque.nwrc.ars.usda.gov/~ipw.

Marks, D., A. Winstral, M. Reba, J. Pomeroy and M. Kumar, 2013, An evaluation of methods for determining during-storm precipitation phase and the rain/snow transition Elevation at the surface in a mountain basin, *Advances in Water Resources*, **55**: 98-110, http://dx.doi.org/10.1016/j.advwatres.2012.11.012.

Pierson, F.B, C.W. Slaughter and Z.K. Cram, 2001, Long-term stream discharge and suspended sediment database, Reynolds Creek Experimental Watershed, Idaho, USA, *Water Resources Research*, **37**(11), 2857–2861.

Yang, D. Q. et al. (1999), Quantification of precipitation measurement discontinuity induced by wind shields on national gauges, *Water Resour. Res.*, ***35***(2), 491–508, doi:10.1029/1998WR900042.

Zahumenský, I., 2004, Guidelines on quality control procedures for data from automatic weather stations, *World Meteorological Organization, Switzerland*, **955**, 2–6.